

# Building Internet Accessible Medical Education Software Using the World Wide Web

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*We describe work to enhance existing software protocols and develop a suite of new software utilities based upon a set of standards known as the World Wide Web (WWW). Specifically, we have developed an effective X-windows based WYSIWYG WWW browser/editor and a prototype for integrated wide-area authentication and authorization support for delivery and maintenance of WWW service. These software development activities, along with parallel work in content development, are empowering individuals to better use the Internet as a resource to easily author, publish, and access materials.*

*As an illustrative application, we describe one Web-based self-instructional unit designed to increase users' knowledge of hazardous substances in the environment. This on-line monograph was adapted from a series of paper-based case studies developed by the Agency for Toxic Substances and Disease Registry of the U.S. Department of Health & Human Services. The on-line version illustrates many of the innovative features provided by the Web, and demonstrates how such materials can significantly impact medical education at all levels.*

## INTRODUCTION

With over thirty years of active development, the announcements, reviews, and scholarly papers describing Computer Assisted Instruction (CAI) and other technology-based medical education efforts would fill volumes. However, in general, the impact of instructional technology on the medical school and generalist science curricula has been at best modest [1, 2].

This fact notwithstanding, there is today ample proof that, in the *proper* setting and in the hands of *properly* trained users, computer supported learning *can* work [3, 4]. Hypermedia systems are one particularly promising CAI tool. These have the potential to let students experience an active, personalized, and inquiry-based exposure to medical content and problem solving. When empowered with appropriate hypermedia tools, students can selectively discover, access, and retrieve relevant information from the content overload they currently face [5].

Such systems have the promise to dramatically impact medical education, yet they suffer from a devastating drawback. Due to the proliferation of computers in classrooms, laboratories, dormitory rooms and homes, and to the parallel growth in the number of proprietary hypermedia software tools and applications running on these systems, a modern day technological Tower of Babylon has been created. As a result, the computer functions as an information island, unable to tap into the wider web of an ever growing communal knowledge base.

Recently though, two significant developments in information technology have occurred that make the goal of seamlessly accessing and integrating the many distributed networked information resources and services realizable.

## THE INTERNET & WORLD WIDE WEB

The first is the government sponsored effort to establish "information superhighways" using the established Internet networking infrastructure and protocols. This effort has already linked 100% of the American Research Level I Institutions; improvements in Wide Area Networking technologies are allowing additional sites -- from the home office to the local high school to the rural primary care clinic -- to join this networked world-wide community.

The second development is the creation of the World Wide Web (WWW). The World Wide Web project merges the techniques of information retrieval, hypermedia, and open standards to build an easy but powerful global information system. Originally developed at CERN for the High Energy Physics community, it has spread to many other areas and attracted much interest in user support and resource allocation. It is currently the most advanced information system deployed on the Internet, and it offers the greatest promise for future development of wide area information platforms and collaborative "groupware" applications. Significantly, its application and potential use in the academic medical community has not gone unnoticed [6].



The Biological Sciences Division office of Academic Computing (BSDAC) at the University of Chicago has begun enhancing existing software protocols and developing a suite of new software utilities based upon the World Wide Web architecture. This effort in total is named the Phoenix Project; its aim is to develop an integrated academic information system providing full Internet connectivity and wide-area distributed hypermedia authoring services to the students, teachers, researchers, clinicians, and administrators who comprise BSDAC's user base.

Our efforts toward these goals include two significant areas of enhancements to the WWW: an effective X-Windows based What You See Is What You Get (WYSIWYG) WWW browser/editor, and a prototype for integrated wide-area authentication and authorization support for WWW-based file service.

### **The Phoenix WWW Editor**

Aside from a number of conversion utilities (rtf2html, LaTeXToHTML, ps2html) and rudimentary HTML editors (tkWWW, NextStep editor, the WYSIWYG Hypercard Stack, EMACS HTML-mode), no easy to use WYSIWYG WWW editor exists. Because our goal is for content experts and novices alike to directly author their own materials for publication on the WWW, we first needed to develop a WYSIWYG WWW editor.

Figures 1 and 2 show "browsing" and "authoring" views, with supporting feature explanations, of our first generation Phoenix client. This software currently runs as an X-windows application, and is thus accessible from the three preferred operating systems on our campus: Macintosh, MS DOS/Windows, and UNIX.

Besides supporting an easy to use WYSIWYG interface, an important feature of Phoenix is its ability to share the contents of its clipboard with a remote client's clipboard. This both reinforces a common interface between the PC and Phoenix environments, and facilitates the integration of the Phoenix editor within the user's local (primarily Macintosh and MS DOS/Windows) application environment.

Another unique feature of Phoenix centers on its handling of the underlying WWW file system. Because conventional distributed file systems (Appleshare, NFS, etc.), typically represent systems that support standalone documents lacking a comparable degree of integration found in the WWW environment, we have departed from the standard file system interface and instead *transparently* provide file services to Phoenix users. By using aliases, all basic file operations can be performed via indirect references

to the underlying WWW file locator identifiers (called URLs for Uniform Resource Locators), user and group names that use existing URL aliases (such as Hotlist, and History items), as well as novel aliases corresponding to users and groups.

We have also included support for a suite of "second generation" (HTML+) WWW information features, including in-line images (GIF format) and ISMAPs, in both browse and edit modes.

### **Enhanced Security Features**

Currently, WWW users enjoy read-write access to existing information services provided by WWW servers according to the authoring/browsing permissions governing the underlying WWW documents (predominantly world-read, local-write). Integrated organization of these distributed information resources is thus achieved using existing features in the WWW framework (HTML, for Hypertext Markup Language, and HTTP, for Hypertext Transfer Protocol). However, in a wide-area multi-server authoring environment in which users belonging to multiple groups can selectively browse and edit information, the existing HTML/HTTP implementation requires extension in the areas of user authentication and authorization.

We have thus implemented a prototype for integrated wide-area security support for maintaining information placed on the WWW framework. This implementation addresses two key deficiencies of the current WWW, namely support for abstracting personalized views of information resources and (due to the lack of a robust WYSIWYG editor), the ability to selectively edit and add to information or other computing resources.

## **BIOMEDICAL CONTENT DEVELOPMENT**

With the enabling Phoenix software utilities in hand, we have set about building a suite of information resources in the area of primary care medicine. The content providers for this work are the clinical faculty in the University Health Service (UHS), the general medicine clinic and student and employee health service at the University of Chicago Medical Center (UCMC). As we have described previously [7], the primary care practice at the UHS represents an unparalleled resource in which to design and test new patient and student centered curricular and care programs. It is in support of these efforts that we have developed a prototype content repository and organization for clinical and health education materials.

"Case Studies in Environmental Medicine" is a suite



of self-instructional units designed to increase a user's knowledge of hazardous substances in the environment. The on-line resources were adapted from a series of paper-based case studies developed by the Agency for Toxic Substances and Disease Registry of the U.S. Department of Health & Human Services.

In addition to providing the same information as the paper units, the on-line counterparts contain additional graphics and supporting information utilities such as a full featured glossary. They also contain links to relevant "in-house" resources, such as the UHS Health InfoLine, a WWW-based collection of health information materials available to the University of Chicago community. Demonstrating the leveraging rewards available when using the Internet-wide WWW framework, the case studies contain links to appropriate off-site information resources. Finally, using the forms features of the WWW, the on-line versions support drill and practice presentations including multiple choice questions with corrective feedback; this feature also enables users to electronically submit post-test responses for automatic assignment of credit.

In designing the delivery platform for these materials, we have employed a number of innovative and unique WWW enhancements, including:

- the use of relational database technology to support a fine grained data schema. This approach allows information content to be viewed from multiple perspectives, with those perspectives determined by the aims and needs of the individual user. A novice student accessing a Lead Toxicity unit in support of a Health Education class would necessarily both want and need a different view on the content than the practicing clinician using the unit to diagnose lead poisoning in a patient;

- dynamically built page 'mosaics' instead of static WWW documents. Because the case studies information content resides in a database repository, individual pages can be dynamically "assembled" on the fly. This enables the multi-perspective data views mentioned above, as well as allows for easy maintenance of the content. When information is updated in any of the underlying databases, the resulting documents will automatically reflect any changes. As new software features are added, a simple modification to the script that generates a page modifies all appropriate documents; and

- consistent design format. The top of every page displays a consistent organization and presentation of graphics that in addition to providing visual anchor clues to the user, also provides links to appropriate higher level information pages. These features help

prevent the "lost in hyperspace" condition often experienced in rich hypermedia systems.

These efforts demonstrate how integrated hypermedia systems can be built using non-proprietary international standards. Indeed, it may be that this approach is the first to fully realize the goals of efforts such as the National Library of Medicine's IAIMS project to provide institution-wide access to appropriate bibliographic and knowledge databases and present them in an integrated fashion [8]. Together, these utilities suggest that a new dawn in the use of information technology is at hand.

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## 1

**Create New Page:** creates a new page and switches Phoenix to author mode

**Open:** opens a document residing on the local machine (bio-3.bsd.uchicago.edu for Phoenix users at the U of C)

**Goto URL:** Opens a document via HTTP; you must specify the full address (Uniform Resource Locator, URL) of the document you wish to access. The URL for the BSDAC home page, for instance, is <http://bio-3.bsd.uchicago.edu/index.html>.

**Get info:** invokes an information dialog box describing the features of the current page.

**Save As...** : invokes a save file dialog for specifying the desired destination to which the current page is to be saved in HTML format.

**Save Text...**: as above, except that the document will be saved as **TEXT-ONLY**.

**Print:** Prints the current document to the printer specified in the popup dialog box.

**Mail:** mails the current document to the recipient specified in the popup dialog box.

**Quit:** Closes the given Phoenix window; it does not affect other Phoenix windows.

**View HTML:** Displays document Hypertext Markup

## 2

**Copy:** copies the current selection to the Phoenix clipboard (it also copies selected text to the Macintosh clipboard, if Phoenix is run using MacX).

**Find:** invokes a dialog box in which to specify keywords for a Wide Area Information Services (WAIS)

## Change Fonts: pops-up a font selector dialog box

## 4

This menu lists the titles of the documents through which you have browsed with the current Phoenix window (if the document does not have a title, the URL is listed instead). Selecting a given menu item from here will retrieve the corresponding document in the current Phoenix window.

## HOTLIST MENU

The hotlist is a list of bookmarks enabling the rapid retrieval of your favorite world-wide-web documents

**Add Page to Hotlist:**  
adds the current document to the hotlist.

**Delete from Hotlist:**  
deletes the current document to the hotlist.

## ANNOTATE MENU

Annotation are private text-only notes you can attach to documents on the web.

**Add Annotation:**  
adds annotation to the your view of the current window.

**Edit Annotation:**  
edit current annotation (You must be viewing the annotation to edit it)

**Go to Annotation:** displays the annotation selected from the pull-down menu

## HELP MENU

**Provides access to Help for Phoenix, Phoenix-browser, and Mail**

## APPLICATION MENU

The application menu is used to launch applications, to navigate between Phoenix windows, to set your Phoenix password, and to exit Phoenix.

**Web-Browser:** provides a pull down menu of active Web-browser windows.

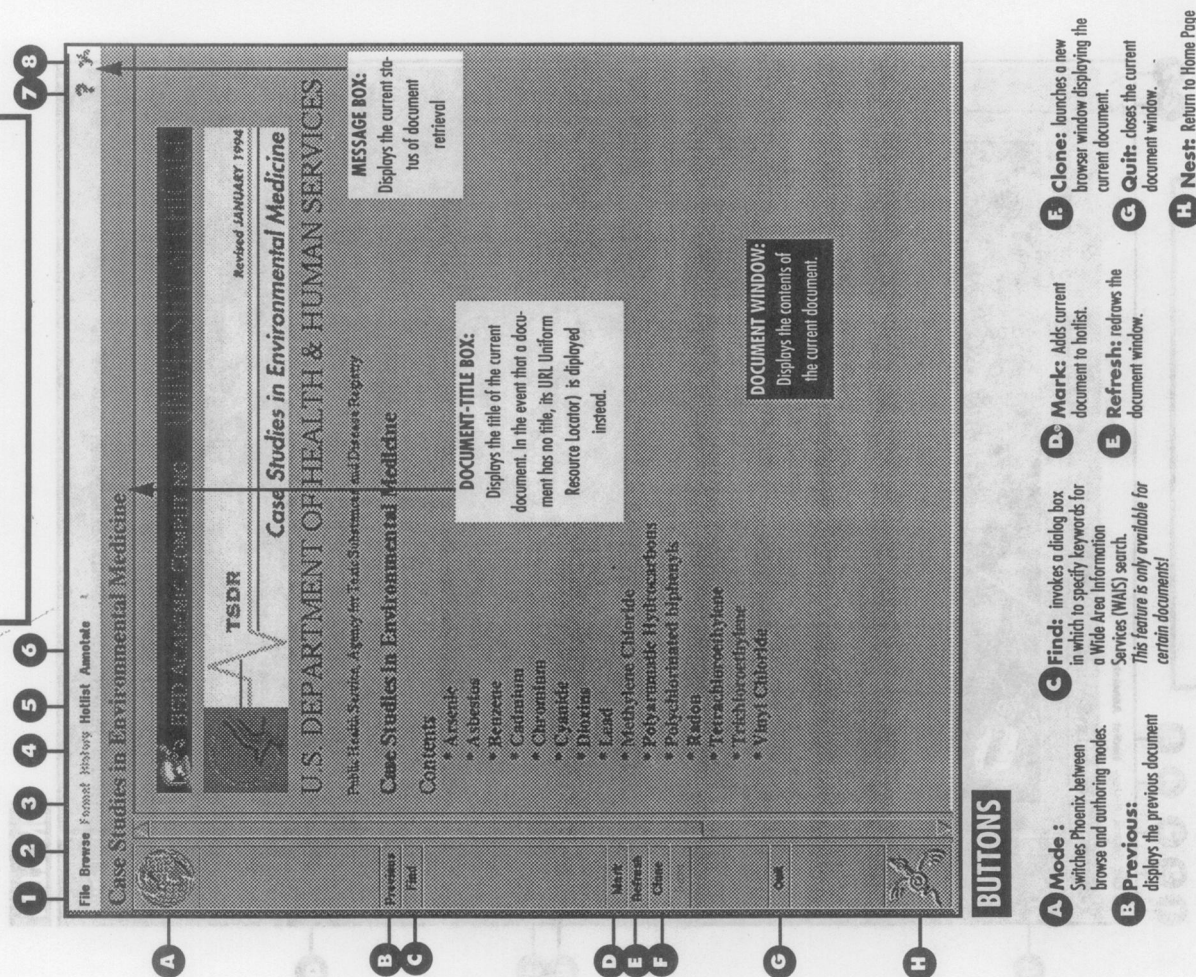
**Mosaic:** launches the NCSA web-browser (useful for viewing documents containing HTML forms)

**XV:** launches the XV image viewing/editing software

**Medline:** launches a telnet session to the Ovid Medline server (You will need a Ph alias and password to use this resource).

**Configure:** use this to change your password

**Exit Phoenix:** terminates you current Phoenix session, logging you out of the Phoenix server.



### Figure 1. Overview of Phoenix Browsing Features



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# PHOENIX AUTHORING

## FORMAT MENU

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## HISTORY MENU

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## HOTLIST MENU

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## HELP MENU

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## APPLICATION MENU

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## BUTTONS

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### Figure 2. Overview of Phoenix Authoring Features